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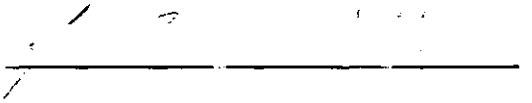

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PLANNED RESEARCH AND DEVELOPMENT DISTRICTS

A THESIS

Presented to

The Faculty of the Graduate Division

by

Joe Parks Walters

In Partial Fulfillment

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PLANNED RESEARCH AND DEVELOPMENT DISTRICTS

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SUMMARY

The purpose of this study is to provide assistance to developers of planned research and development districts and to city planners in the communities concerned. The study discusses: (1) the characteristics of such districts, (2) how they are planned, and (3) the author's survey of two selected districts.

Planned research and development districts are defined by the study as tracts of land which are subdivided and developed according to a plan and restricted to: (1) research and development operations, (2) prototype manufacturing, (3) light manufacturing, and (4) offices. Most districts are located within 20 miles of (1) a university with a graduate program in science and engineering or (2) a major scientific complex of the United States Government.

The study states that there is an over capacity of planned research and development districts and that many have been poorly located. This has caused most districts to be financially unsuccessful.

Developers and planners can receive assistance from the study's discussion of how to determine a community's potential for a research and development district. The factors which determine potential are: a major attractor (a university or a scientific complex), supporting services, air transport services, and community amenities. The study also discusses the factors which must be considered in selecting the site for a district and how the site can be acquired. Recommendations

are made for planning the site and providing it with utilities. Management and operation are discussed with emphasis on development controls, especially zoning and restrictive covenants.

CHAPTER I

INTRODUCTION

Planned research and development districts are relatively new enterprises. They have some of the characteristics of industrial districts but there are important differences between the two. Research and development districts have major research functions, are more restrictive than industrial districts in the types of activities admitted, are more specialized in the services made available to clients, and can be developed at fewer locations.

Many industrial districts admit research and development facilities and some have been promoted by their owners as "research parks." This has been done to gain prestige from the current emphasis on research and development.

For the purposes of this study a planned research and development district is a tract of land which is subdivided and developed according to a plan and is restricted to:

1. Research and development operations,
2. Prototype manufacturing,
3. Light manufacturing, and
4. Offices.

Most successful research and development districts are located within 20 miles of (1) a university with a graduate program in engineering and science or (2) a major scientific complex of the United States

Government.[1] A list of typical districts which meet the definition above is given in Appendix A.

Planned research and development districts have been established to fulfill two important needs of research and development as an activity.

1. This activity is highly dependent on people who are very creative and are sensitive about where they work and live. Many such people are found in areas near first rate universities; therefore, these areas have a particular advantage for research and development districts as real estate developments.

2. Most research and development operations require highly specialized services and supporting facilities which they cannot provide for themselves. These services and facilities can be economically made available in a planned district and can be shared by a group of research and development operations or can be obtained from a nearby university or federal establishment. The services and facilities referred to here will be discussed in detail in a following chapter.

Research and development, as the term implies, has two distinct stages: the research stage and the development stage. A distinction can also be made within the research stage between basic research and applied research. Basic research is the search for new scientific knowledge with no specific, practical application in mind. In other words basic research has no commercial objectives.[2] Applied research is scientific investigation and experimentation for a practical or commercial purpose. Development is the transforming of a scientific discovery into a workable prototype or process.[3]

Purpose

The purpose of this study is to analyze the characteristics of research and development districts, determine how they are planned, and describe how they are operated. It is especially important that city planners and public officials who have a pertinent interest in this subject be made aware of the methods and controls which are used to make planned research and development districts compatible with nearby land uses. Of equal importance is the assistance which this study can provide potential developers who are considering the establishment of such districts.

Approach

This study discusses the different types of planned research and development districts and how they are organized and operated. Emphasis is also given to the factors that influence the location of districts and to their land use controls. This information was compiled from a review of pertinent literature, from visits to selected districts, and from personal interviews and correspondence with officials of such districts.

Thesis Organization

The remainder of this study discusses in detail planned research and development districts. Chapter II analyzes the characteristics of the districts that have made information available to the author. Chapter III tells how districts are planned and Chapter IV presents a description of two selected districts.

CHAPTER II

CHARACTERISTICS OF PLANNED RESEARCH AND DEVELOPMENT DISTRICTS

This chapter will discuss the most important characteristics of planned research and development districts. For purposes of discussion the characteristics have been grouped as follows: (1) general, (2) organizational, and (3) development controls.

General Characteristics

General characteristics include: (1) location, (2) size, (3) supporting facilities, (4) occupants, and (5) financial success.

Location

The locations of the planned research and development districts surveyed for this study were influenced by two dominant types of developments: (1) a university with a graduate program in science and engineering, and (2) a scientific complex of the United States Government. Thirty-six of the districts surveyed for this study are located within 20 miles of a university or group of universities. Two districts are located near United States Government science complexes.

Size

The 38 districts surveyed for this study vary greatly in size. They range from the nine-acre University Circle Research Center in Cleveland, Ohio, to the 5,000-acre Research Triangle Park in North

Carolina (see Table 1). Only four of the districts contain more than 1,000 acres and 12 have less than 100 acres. The remaining 22 vary from 100 to 1,000 acres.

Supporting Facilities

In late 1965, 200 industrial research laboratory directors were asked by the Colorado Industrial and Research Campus (Boulder) which supporting facilities they considered most important.[4] Sixty-one per cent of the directors responding to the survey reported that they considered computers to be the most important facility for the support of research and development. Fifty-two per cent of those responding ranked a library as the most important facility available from a university.[5]

Other facilities which are important to research and development laboratories are instrument repair shops, machine shops, and glassblowing shops.

Supporting facilities are available to the occupants of planned research and development districts through two arrangements: (1) the occupants' own arrangements for facilities within the surrounding urban area, and (2) by special arrangement made for the occupants by the district management.

Occupants' Own Arrangements. Some districts have no supporting facilities available. An example is the National Capital Research Park in Rockville, Maryland. This privately-owned district, located near Washington, D. C., has no official relationship with a university and its occupants must make their own arrangements for supporting facilities in the Metropolitan Area.

Table 1. Characteristics of Selected Research and Development Districts

District and Location	Developer	Ownership	Size	Per Cent Occupied	Near University	Near Research Center	Features
Research Triangle Park: North Carolina	Research Triangle Park, Incorporated (Non Profit Corporation)	Research Triangle Foundation	5,000 acres (1,000 as a Research District, 4,000 as a Research Application District)	20%	Duke University-Durham, University of North Carolina-Chapel Hill, North Carolina State University-Raleigh (7,10, and 15 miles)	Research Triangle Institute located in park	Very large lots for manufacturing purposes (IBM on 400-acre lot
Huntsville Research Park: Huntsville, Alabama	Research Sites Foundation, Inc. a subsidiary of the owner (Non Profit Corporation)	Huntsville Industrial Expansion Committee (Non Profit Corporation)	575 acres	25%	University of Alabama Extension Center (adjacent to park)	University of Alabama Research Institute (adjacent to park)	Lots from 5 to 50 acres
Stanford Industrial Park: Palo Alto, California	Stanford University Land Development Department	Stanford University	700 acres	65%	Stanford University	Stanford Research Institute	Land for lease for maximum of 51 years
National Capital Research Park: Rockville, Maryland	Donohoe Construction Company, Washington	Group of Washington, D. C. Businessmen	50 acres	30%	Georgetown University, George Washington University, University of Md.	No	Financial assistance for prospective tenants
Fitchburg Research Park: Madison, Wisconsin	Bjorksten Research Laboratories, Inc.	Bjorksten Research Laboratories, Inc.	175 acres	10%	University of Wisconsin (15 miles)	No	Only one firm from each research field permitted (10 to 99 year lease)
Greater Ann Arbor Research Park: Ann Arbor, Michigan	Greater Ann Arbor Research Park, Inc. (Non Profit Corp.)	Greater Ann Arbor Research Park, Inc.	209 acres	33%	University of Michigan	No	Lots from 2.1 to 28 acres
Connecticut Research Center: Meriden-Wallingford, Conn.	The United Illuminating Co. and the Connecticut Light and Power Company	The United Illuminating Co. and the Connecticut Light and Power Co. (Investor-owned Utilities)	1,000 acres		Yale University (20 miles)	No	90% financing available on buildings up to $5 Million
University of Missouri Research Park: Columbia, Missouri	University of Missouri	University of Missouri	85 acres	40%	University of Missouri (adjacent to park)	No	
Santa Barbara Research Park: Santa Barbara, California	Exchange Building Corporation	City Title Insurance Company	230 acres	60%	University of Cal. at Los Angeles (adjacent to park)	Santa Barbara Research Center	Santa Barbara Airport Nearby
Sunset Science Park: Portland, Oregon	Sunset Science Park, Inc. (Subsidiary of Owner)	Electro Scientific Industries, Inc.	100 acres	8%	Portland State University, University of Portland	No	

By Special Arrangement. The management of several districts have made arrangements for their occupants to use supporting facilities which are located on the district site or at a nearby university.

Examples of on-site facilities which are available to district occupants are the ten million watt nuclear reactor in the University of Missouri Research Park and the Merrick Computer Center in the University of Oklahoma Research Park. Almost all on-site supporting facilities located in districts are in university districts and are research type facilities, rather than maintenance or supply facilities (such as instrument repair and glassblowing shops).

Examples of university facilities not in districts which are available to district occupants are the following. Colorado State University's Computer Center is available to the occupants of the university's research park. The 2,600,000 volumes of the Cornell University Library can be used by the occupants of that school's research park. The occupants of University Circle Research Center in Cleveland, Ohio, have access to the computers of Case Institute of Technology and Western Reserve University on a non-interference basis.[6]

Occupants

Two types of occupants predominate in planned research and development districts: (1) research and development laboratories and (2) light manufacturing plants.

Research and Development Laboratories. The four types of research and development laboratories in the districts surveyed are:

1. Research laboratories of manufacturing concerns.
2. Contract research laboratories.

3. United States Government laboratories.

4. University research laboratories.

Research and development laboratories of manufacturing concerns have been located in districts to utilize the services of facilities that are often not available at the firm's manufacturing plant. Many of the manufacturing concern's research divisions located in districts are engaged in prototype manufacturing and other limited manufacturing linked with research and development.

A number of contract research laboratories are located in planned research and development districts. Examples are: The Bjorksten Research Laboratories in the Fitchburg Research Park near Madison, Wisconsin, and Opinion Research Corporation in the Princeton Research Park, Princeton, New Jersey.

The United States Government has located several research laboratories in planned research and development districts. Examples are the U. S. Weather Bureau Research Laboratory in the University of Oklahoma Research Park and the U. S. Forest Service Forestry Sciences Laboratory in the Research Triangle Park, North Carolina.

Universities have located research laboratories in the districts they have developed. An example is the Animal Behavioral Laboratories of the University of Oklahoma in the University of Oklahoma Research Park.

Light Manufacturing Plants. Light manufacturing plants are in 25 of the districts surveyed. This type of occupant is the most numerous in several districts. The reason for this is that many dis-

tricts cannot attract enough research and development laboratories to be financially successful. This has caused them to admit light manufacturing firms on a selective basis. Also, financial institutions lend money more willingly for facilities to be built in districts which have mixed uses. Mixed uses offer a firm more chances to sell or sublease its building in the event that this becomes necessary[7].

Financial Success

Most research and development districts are not financially successful. There is an over capacity of districts and several have been poorly located.

The number of research and development facilities located in districts is small compared to the total research and development effort.[8] Districts appeal mainly to the small research facilities which find it difficult to create their own environment. Large research facilities tend to locate on independent sites.[9]

Organizational Characteristics

This part of the study will discuss the organizations that have developed districts.

Organization for Development

The organization which develops a district is responsible for the assembly and financing of the land, the preparation of a development plan, site preparation, the preparation of development standards, the provision of utilities, the sale and leasing of land, the promotion of the district, and its continuing operation and maintenance.[10]

The organization for development may contract with specialists

for some of these services. For example, it may arrange for a real estate firm to promote the district and handle the leasing and sale of land.

Four types of organizations have developed planned research and development districts: (1) private corporations, (2) public corporations, (3) universities, and (4) a municipality. (See Table 2.)

Private Corporations. Most of the private corporations which have developed districts are real estate firms. However, a construction company has developed a district and two electric utility companies have joined forces to develop a district.

Private corporations have developed districts for one reason: to make a profit (1) on the sale or leasing of land, or (2) on the leasing of buildings. They can make the greatest return on their investment by leasing land and buildings rather than by the outright sale of land.[11] Private corporations usually offer a wider range of development services to their prospective occupants than the other types of developers. Such services include financial assistance if the occupant wishes to buy land and a "package" plan on land and building if he wishes to lease.

Public Corporations. Selected public corporations which have developed districts are shown in Table 2. Most of the public corporations which have developed districts were formed by civic-minded leaders. The main interest of such groups in developing a district is to improve the economic stability of their communities.

Public corporations have two main advantages for civic-minded

Table 2. Selected Developers of Planned Research and Development Districts

Developer	District and Location	Major Characteristics of Developer
PRIVATE CORPORATIONS		
Danac Real Estate Investment Corporation	Danac Technological Park, Rockville, Maryland	Profit corporation, has several real estate developments in the Washington, D. C. area
Cabot, Cabot and Forbes Company	Technology Square, Cambridge, Massachusetts	Private real estate company, specializes in the development of industrial property
Connecticut Light and Power Company and United Illuminating Company	Connecticut Research Center, Meriden, Connecticut	Investor-owned electric utilities
Donohoe Construction Company, Inc.	National Capital Research Park, Rockville, Maryland	Private construction company
PUBLIC CORPORATIONS (Including Foundations)		
Research Sites Foundation, Incorporated	Huntsville Research Park, Huntsville, Alabama	Non-profit corporation, land holding subsidiary of the Huntsville Industrial Expansion Committee
International Science Foundation	International Science Center, Sunnyvale, California	Non-profit organization, supported by U.S. and foreign businesses, engaged in the exchange of scientific information

Table 2. Selected Developers of Planned Research and Development Districts (Continued)

Developer	District and Location	Major Characteristics of Developer
PUBLIC CORPORATIONS (Including Foundations) (Continued)		
Research Triangle Park, Incorporated	Research Triangle Park, Raleigh, North Carolina	Non-profit corporation, wholly owned subsidiary of the Research Triangle Foundation
University Circle Research Center Corporation	University Circle Research Center, Cleveland, Ohio	Non-profit corporation, formed by Case Institute of Technology and Western Reserve University to develop the center
UNIVERSITIES		
University of Georgia	University of Georgia Research Park, Athens, Georgia	State land-grant university
University of Oklahoma Research Institute	University of Oklahoma Research Park, Norman, Oklahoma	Non-profit corporation, administers research contracts for the University of Oklahoma
Cornell University	Cornell Industry Research Park, Ithaca, New York	State and private land-grant university
University of Missouri	University of Missouri Research Park, Columbia, Missouri	State land-grant university
MUNICIPALITY		
Oakland, California, Industrial Development Commission	Peralta Oaks Research Center, Oakland, California	Municipal agency, engaged in industrial development for City

leaders to use for the development of a district.

1. Public corporations can qualify as non-profit organizations under Section 501(e)(3) of the Internal Revenue Code.[12] This means that their entire earnings, if any, can be reinvested in the development of the district.

2. Public corporations can solicit and receive funds for development costs from business leaders and other sources of capital. For example, (1) the Research Triangle Foundation received $2,000,000 in donations from the business and industrial interests of North Carolina[13] and (2) the University Circle Research Center Corporation (Cleveland, Ohio) received grants of $375,000 from Case Institute of Technology, Western Reserve University and the Cleveland Development Foundation.[14]

Universities. Examples of universities which have developed districts are shown in Table 2. Universities have used three types of organizations for this purpose:

1. A university research institute.

2. The university administration.

3. A contract developer.

Some universities have used their research institutes to develop districts because the institutes, being semi-autonomous organizations with their own charters, can do this without interfering with the primary purpose of the university, education. Another advantage is that, even though the research institutes are semi-autonomous, they can adhere to the general policies of the university in developing a district. This is because their administrative organizations (board of directors) are interlocked with the university administration.[15]

The university administrations of six schools have developed research districts. On the basis of information available to the author, this approach for development takes two forms: (1) a special committee composed of faculty members and university officials, and (2) the office of a specially appointed university official.

1. The development of the University of Missouri Research Park is the responsibility of a committee composed of the Director of the University's nuclear reactor (Committee Chairman), the Dean of the College of Engineering, the Business Manager of the University, and the Dean of Research Administration.[16]

2. The Cornell University Industry Research Park was developed by the Office of the Director of the Research Park, a division of the university administration.

Developmental organizations which are part of the university administration have two disadvantages:

1. They put the university directly in the real estate business.

2. They create the possibility of distracting faculty and administrative officials from their primary duties within the university.[17]

The remaining organization for the development of university districts is the contract developer. Technology Square in Cambridge, Massachusetts, is an outstanding example of this practice. Massachusetts Institute of Technology has contracted with Cabot, Cabot, and Forbes, a Boston real estate developer, to develop the district. Massachusetts Institute of Technology pays 85 per cent of the development costs and Cabot, Cabot, and Forbes pays 15 per cent, but the school

receives only 66-2/3 per cent of the profits and the developer receives 33-1/3 per cent. The developer receives a larger share of the profits than it makes to the development costs because it provides the development "know how."[18]

Municipality. One municipality (Oakland, California) has developed a district, the Peralta Oaks Research Center. The organization responsible for the development of this district is the city's Industrial Development Commission. This is a six-man commission, the members of which are appointed by the Mayor.

Development Controls

The administration of planned research and development districts is faced with the problem of maintaining proper development controls over the district. It is to the advantage of the administration and the occupants that the district have stability in operation, function, and appearance. In order that these qualities be maintained, control must be had over building design, permitted uses, site coverage, off-street parking, landscaping, signs, and other aspects of development.

Three things are used to control development:

1. Review of development proposals (of occupants and prospective occupants) by the district administration.
2. Restrictive covenants.
3. Zoning.

The first of these is a right held by the property owner; the last two are legal devices used to control the development of land.

Review by District Administration

The administration of several districts controls development by requiring prospective occupants to submit their development plans for review. This is done for two reasons:

1. To admit only those occupants whom the administration considers desirable.

2. To control the details of individual site development.

This method of control is used by Stanford University for its Industrial Research Park at Palo Alto, California. A prospective tenant must submit a conceptual plan of the way in which the site will be developed to a committee of the university faculty. This committee reviews the plan and, if approval is given, it is then passed to the university trustees for their approval. After the trustees approve the conceptual plan, the prospective tenant must submit a detailed plan of development to the University Office of Real Estate for final approval.

Restrictive Covenants

Restrictive covenants, sometimes called deed restrictions, permit the enforcement of agreements between seller and buyer stating that the buyer will make only certain specific use of the land and will restrict such use to conform with certain established criteria.[19] Some of the things which the administrations of districts have used restrictive covenants to control are: permitted uses, lot coverage, parking requirements, landscaping, signs, outdoor storage, fencing, and building height, set-back, and alteration.

For purposes of giving the occupants some voice in the enforcement

of restrictive covenants, the administration of some districts have made provisions for owners and tenants associations and boards of design in their restrictive covenants.

Owners and Tenants Associations. At least four districts have provisions for owners and tenants associations in their restrictive covenants (see Table 3). The principal function of these associations is to appoint members to the boards of design. This is illustrated by the association of the Santa Barbara Research Park, Santa Barbara, California (see Appendix B).

The association of the Denver Technological Center has an additional function. This association is given the function of "maintaining, improving and beautifying areas and facilities used in common such as out lots in streets, street-lighting and park and open areas."[20] In order to carry out this function the association must organize a legal entity authorized to hold title to real property (see Figure 1, on the following page).

Boards of Design. All of the Boards of Design investigated for this study include five members. The members are usually appointed as follows: as long as 20 per cent or more of the district is held by the district owner, he appoints three members and the Association appoints two members. After less than 20 per cent of the district is held by the district owner, he appoints two members and the Association appoints three.

By retaining majority membership on the Board of Design until the district is at least 80 per cent occupied, the owner can control development in a manner which will protect his investment.

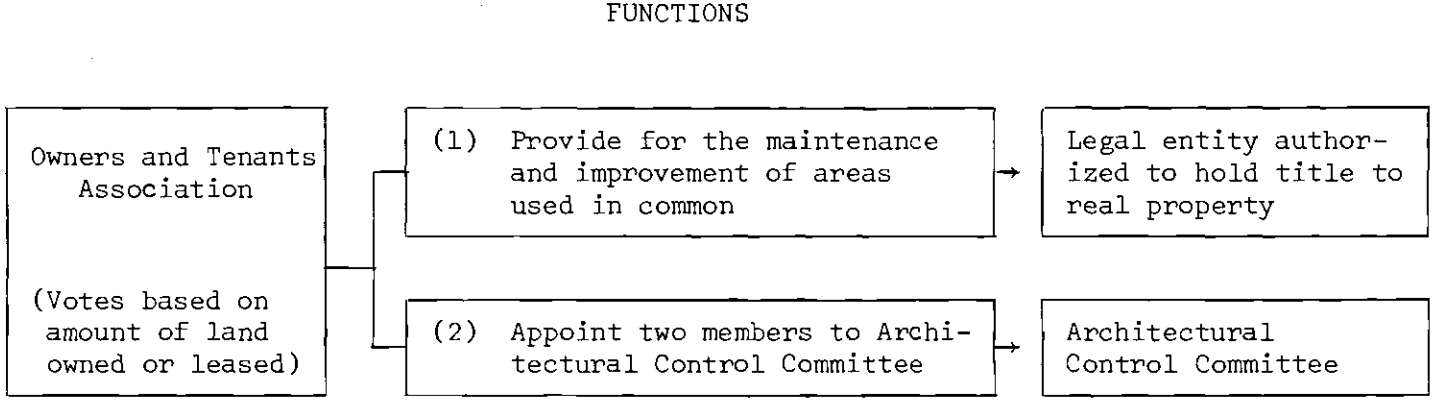

Figure 1. Functions of the Owners and Tenants Association of the Denver Technological Center

Table 3. Owners and Tenants Associations of Selected Planned Research and Development Districts*

District	Tenant's Votes	Principal Function
Santa Barbara Research Park, Santa Barbara, California	One vote per acre	Appoint members to the Board of Design
Clear Lake City Research Park, Houston, Texas	One vote per acre	Appoint members to the Board of Design
Research Triangle Park, Raleigh, North Carolina	OWNERS Two for each acre owned and not leased. One for each acre owned and leased. LESSEES One for each acre leased	Appoint members to the Board of Design
Denver Technological Center, Denver, Colorado	One for each 10,000 square feet of land owned (owners may assign votes to lessees)	To be responsible for maintenance and improvement of common land in the center. Appoint members to the Architectural Control Committee

*Information based on districts' restrictive covenants.

The function of the boards of design is to approve or disapprove all uses, building construction, and site development in the district. In regard to building construction (and alteration) and site development the Board of Design of the Santa Barbara Research Park is given the following function by the district's restrictive covenants:

> No construction or exterior alteration of buildings, utilities, signs, pavements, landscaping, or other exterior facilities may be initiated without approval of plans by the Board of Design.[21]

Zoning

Zoning is the division of a municipality (or other governmental unit) into districts and the regulation within those districts of:

1. The height and bulk of buildings and other structures.

2. The percentage of a lot that may be occupied and the size of required yards and other open spaces.

3. The density of population.

4. The use of buildings and land for trade, industry, residences or other purposes.[22]

The following sections will discuss how zoning is used to control development in planned research and development districts. Because of the similarity of some of the terms used, the following definitions are necessary:

1. District--a planned research and development district (park).

2. Zoning district--a division of a government unit for zoning purposes.

3. Development--the making usable of land in a district by the installation of facilities.

Research and development districts are located in special (purpose) zoning districts. These districts have been established to provide greater land use control and development standards than afforded by the usual commercial and industrial zoning districts. Research and development districts are located in two types of special zoning districts:

1. Those specifically for research and development uses.
2. Other special zoning districts.

Research and Development Zoning Districts. Zoning districts have been established to meet the specific needs of planned research and development districts. The provisions of these zoning districts controlling lot coverage, minimum building set-back, minimum lot size and parking space are set forth in Table 4.

Uses permitted in the districts are also controlled by zoning, as shown by Appendix C. This appendix also shows that some of the zoning districts specifically for research and development uses also permit manufacturing and assembly operations if they are performed in connection with research and development. An example is in the Research and Development District of the Washington County, Oregon, Zoning Ordinance (see Appendix C, Sunset Science Park, Portland, Oregon).

Other Special Zoning Districts. Planned research and development districts are permitted in several special zoning districts established primarily for other uses. An example is the Industrial Park Zoning District, I-3, of the Montgomery County, Maryland, Zoning Ordinance. This zoning district was established so that industry could operate in

Table 4. Zoning Provisions of Selected Research and Development Districts

District	Applicable Zoning Ordinance	Zoning District	Maximum Lot Coverage	Minimum Building Set Back (Front)	Minimum Lot Size	Parking Requirements
Stanford Industrial Research Park, Palo Alto, California	City of Palo Alto, Article 15B May, 1960	L-M-5 Limited Manufacturing Large Site District	20%	100 feet	5 acres	One car space for each 200 gross sq. ft. of building floor area, or one space for each 1.5 employees, whichever is greater
Greater Ann Arbor Research Park, Ann Arbor, Michigan	City of Ann Arbor, Art. 5:23(4). Jan., 1963	RE, Research District	30%	75 feet	60,000 square feet	As required in Chapter 59 of the City Code
Sunset Science Park, Portland, Oregon	Washington County,Ore., Art.1150-1166. Dec., 1966	Research and Development District R and D	25%	45 feet	3 acres	One car space for each 1.5 employees during the principal shift at peak employment
Huntsville Research Park Huntsville, Ala.	Huntsville, Alabama, Article 13. March, 1963	Research Park District	30%	75 feet	3 acres, except for permitted residential uses	One space for each 1.5 employees, one visitor space for each 10 employee spaces
Colorado Industrial and Research Campus, Boulder, Colo.	Boulder County,Colo. Section X. October,1965	ED-Economic Development District	Subject to site plan approval by County Planning Commission			Subject to approval by County Planning Commission

Table 4. Zoning Provisions of Selected Research and Development Districts (Continued)

District	Applicable Zoning Ordinance	Zoning District	Maximum Lot Coverage	Minimum Building Set Back (Front)	Minimum Lot Size	Parking Requirements
Manhattan Research Park, Manhattan, Kansas	Manhattan, Kansas, Sec. 12. Feb.,1965	E-1 Research Park District	30%	25 feet from the street right-of-way line or 75 feet from the street centerline, whichever is greater	None	One car space for each 300 square feet of gross floor area, excluding basements

"park-like" developments. Uses permitted include light manufacturing and assembly operations, offices, and research and development laboratories. Two planned research and development districts surveyed (Danac Research Center and National Capital Research Park) are in the I-3 zoning district of Montgomery County, Maryland.

CHAPTER III

PLANNING FOR RESEARCH AND DEVELOPMENT DISTRICTS

Planning for research and development districts includes: (1) determination of local potential for research and development, (2) site selection, (3) site acquisition, (4) site planning, and (5) provision of utilities.

Determination of Potential

Only a limited number of communities have the potential to attract research and development operations. To determine that potential a community should:

1. Assess its advantages for research and development.
2. Estimate the market for research and development.

Advantages Possessed by the Community

An assessment of a community's advantages for research and development is important in determining if it has potential for such operations. In other words, is it attractive to research and development?

The most important things a community should assess are:

1. A major research and development attractor such as a local university or a U. S. Government science complex.
2. Supporting services.
3. Air transport services.
4. Community amenities.

Major Attractors. The most important attractor for research and development operations is a quality university. This was shown in a 1966 survey by *Industrial Research Magazine* in which 200 directors of research and development operations were asked the most important single consideration in the selection of a site. The directors responding to the survey voted the proximity of a university as the most important consideration.[23]

To evaluate the strength of a university as a potential attractor of research and development operations the quality of the graduate school (especially in physical science), the library, personnel, research equipment and research already underway at the university should be considered.

A comprehensive study on university quality was conducted by the American Council on Education in 1966. The Council asked 4,008 scholars to rank 106 United States schools offering doctoral degrees.[24] The schools were ranked in two ways: (1) rated quality of graduate faculty, and (2) rated effectiveness of the graduate program. The findings of the survey can be of value in determining the strength of a university as a potential attractor of research and development.

The university's library and its services are important attractions. Among the things to be considered are the number of technical publications, patent information availability, and whether the library is a depository for U. S. Government science information.

The personnel at the university available for part-time research work is also important. Questions which should be answered are: (1) what is the quality of the faculty and what important contributions

have its members made to their specialties, and (2) how many graduate students are there, especially in engineering and physical science? The policy of the university toward faculty members and graduate students doing off-campus work should also be determined.

Some expensive and specialized research equipment may be available to small research and development operations at a university. Examples are advanced computers, nuclear research equipment, and electron microscopes. As assessment should be made of the research equipment at the university and the conditions under which it will be available to the tenants of a proposed district.

The remaining indicator, the amount and type of research being conducted on campus, should be investigated and compared to that being conducted at other universities which are already major attractors of research and development.

Only two U. S. Government science complexes, the George C. Marshall Space Flight Center in Huntsville, Alabama, and the Manned Spacecraft Center in Houston, Texas, have attracted research and development operations to nearby districts. It is possible that other science complexes will become attractors. In determining if a government science complex has this potential only one factor should be considered. Its strength to attract research and development operations directly related to the complex. All the occupants in districts near the two complexes mentioned are conducting research directly related to those complexes.

Supporting Services. The importance of supporting services to research and development operations is shown by a 1965 survey conducted

by the Colorado Industrial and Research Campus.[25] The directors of 200 research laboratories were asked to indicate the services they considered important. The services indicated to be important are listed in Table 5.

In planning for a research and development district the availability of these services to prospective occupants should be considered in two respects: (1) their location in regard to the district, and (2) the organization through which they will be available, *i.e.*, a university or a private business. The conditions under which they are available should be determined.

Air Transport Services. The managerial and professional personnel of research and development operations must make frequent trips to corporate headquarters. For this reason it is important that excellent airline transportation be available. Especially important is non-stop jet service to New York City, Chicago, Washington, D. C., and the nation's industrial centers.

Community Amenities. In 1966 *Industrial Research* polled 1,133 research scientists and engineers as to their education and income. The poll showed that 72 per cent had incomes of more than $11,000 per year and 29 per cent earned more than $15,000 yearly.[26] The poll also showed that a high percentage of these people had completed graduate school. Such people have a wide choice in where they want to live and work and most prefer to live in communities which provide intellectual stimulation through concerts, art exhibits, theatre, and other cultural activities.

Although it is very difficult to evaluate community amenities, they are a factor which should be appraised in planning for a research

Table 5. Services Indicated to be Important to 200 Research Laboratory Directors

Service	Percentage Indicating Service to be Important
Computer	61
Machine Shop	51
Glassblowing	42
Carpentry Shop	37
Chemical Analysis	28
Sheet Metal	25
Calibration	22
Plating	22
Instrumentation	21
Electronics Design	10
Optical Instrumentation	9
Operations Research	6
Packaging	4
Ultrasonic	4
Antenna Design	0
No Answer	16

Source: *Industrial Research* Magazine, "The Changing Research Parks," May, 1966, page 42.

and development district.

Market for Research and Development

If the community has the required advantages for research and development operations, as discussed in the preceding sections, an indication of the need for a planned district is necessary. In other words, what is the market demand for a district?

The market for research and development space in the geographic area where the district is to be located can be estimated reasonably accurately. This was done in planning for the University Circle Research Center in Cleveland, Ohio. The firm of Ernst and Ernst was hired to survey the management of companies in Northeast Ohio representing 67 per cent of a total of 9,000,000 square feet of research and development space currently in use. The survey showed that the University Circle Research Center would have a minimum market of 190,000 square feet for research and development space and a maximum market of 600,000 square feet by 1970.[27] The center is being planned for 400,000 square feet, or 4.45 per cent of the existing research and development space in the Northeast Ohio area. The firms which expressed the greatest interest in locating in the center were those without existing long-term commitments on space and who were planning to move their research and development operations.

An indication should also be obtained of the national trends in research and development. Questions which should be answered are:

1. Is it an expanding activity, and, if so, in what specialties?

2. Are many new research facilities being built in planned districts or is the trend to build them elsewhere?

An accurate answer to the first question is especially useful in planning a district. The Ernst and Ernst study for the University Circle Research Center indicated that the Center had high market potential for research and development in three specialties: medicine, transportation equipment, and power conversion.[28] The management of the Center is concentrating on attracting tenants conducting research and development in these specialties.

Site Selection

An important step in planning for a research and development district is selection of the site.

As mentioned in Chapter I, the most successful districts are located within 20 miles of a university with a graduate program in engineering and science or a U. S. Government science complex. A site location near one of these facilities is, therefore, essential.

A further "narrowing down" of site selection should be considered from two standpoints: (1) the site's location in relation to other facilities, and (2) general considerations.

Location in Relation to Other Facilities

The author asked the developers of 38 districts what factors were considered in determining location. The replies varied in wording, but four factors stood out:

1. Access to major highway arterials.
2. A physical setting where a campus-like atmosphere can be created.
3. Proximity to:

a. Educational institutions.

b. High-grade residential areas.

c. A jet airport.

4. Access to utilities.

Not mentioned as being important by any of the respondents was the availability of public transportation and rail facilities. The reasons these services are not important are: (1) research and development operations do not employ many persons who rely on public transportation, and (2) the light industries in the districts rely on trucks for receiving and shipping.

General Considerations

The following general considerations are important in selecting the site:

1. Number of parcels into which the site has been divided.

2. Size.

3. Topography.

4. Sub-surface conditions.

Number of Parcels. Purchase negotiations are easier if the site has not been divided into a large number of parcels. The resulting number of owners makes negotiations more difficult. The perfect situation is a site in one parcel with one owner.

Size. As mentioned in Chapter II (page 4) planned research and development districts vary greatly in size. Although no recommendation for size is made by this study, most districts are from 100 to 500 acres. The districts which admit light manufacturing plants tend to be larger

than those which admit only research and development operations.

In planning for size the local zoning ordinance should be checked for lot coverage and parking requirements. This will help in determining how much land is needed for the district.

Topography. Topography, the "lay of the land," must be taken into account in selecting the site. If the district is being planned to contain light manufacturing plants, a slope of more than 10 per cent is not advised.[29] If the district is being planned for research and development operations only, a slope of slightly more than 10 per cent is acceptable, and may even contribute to attractive landscaping.

Excessive slope will increase the amount of grading required and add to the cost of road construction. Grading will cost from $0.50 to $0.75 per cubic yard, so it should be kept within reason.[30]

Sub-surface Conditions. Site preparation and building costs are affected by the site's sub-surface conditions. Except where outcroppings of rock are visible, the only sure way to determine sub-surface conditions is by test borings. The cost of this varies from $2.00 to $10.00 per foot of depth; however, most boring companies charge a minimum of $300.00.[31]

Acquiring the Site

The two methods of acquiring sites are: (1) purchase and (2) lease.

Purchase

Most sites for planned research and development districts are purchased in fee simple. The two methods of purchasing sites are:

(1) outright, and (2) deferred payment. The amount of capital the buyer has will determine which method is used.

Outright. Sites can be acquired by purchase for a specified amount to be paid in a lump sum, or for a certain amount down and the remainder in installments. It is usually to the seller's tax advantage to take as low a down payment as possible and take the remaining payments over as long a period as possible.[32]

Deferred Payment. If the buyer lacks capital, the site can be purchased through a deferred payment contract. This will allow the buyer to pay for the site as he sells lots to tenants. This method was used by the Economic Development Committee of the Ann Arbor (Michigan) Chamber of Commerce in acquiring the site for the Greater Ann Arbor Research Park. The seller signed a long-term contract agreeing that payments for the site would be made from proceeds of lot sales by the Economic Development Committee.[33] The contract specified that the improvements made on the site by the Committee would be a lien on the property if it reverted to the seller.

Lease

Sites can also be acquired by lease. They can be leased for a fixed fee or for a percentage of the income realized from the property.

Site Planning

The site must be divided into blocks and lots and have streets installed before it can be used as a planned research and development district. The developer is advised to check the local zoning ordinance, subdivision regulations and official map before proceeding with site planning.

Block Design

Blocks should be as large as practical because large blocks reduce traffic hazards by reducing the number of intersections. Large blocks also require less street footage and reduce utility costs.

Lot Design

Lots in most planned research and development districts have been plotted in various sizes to meet the needs of prospective tenants (see Figures 2 and 3). This permits plotting the large lots and small ones in the most optimum locations, but it creates the disadvantage of having to make an estimate of the relative demand for large and small lots. If the estimate is excessively incorrect, some lots may go unused. This can be partially overcome by making the plan flexible enough to combine small lots if needed.

Provision of Utilities to the Site

Before the site can be developed into a planned research and development district it must be provided with water, electricity, gas, sanitary sewers, and storm sewers.

Utilities must be extended from utility systems. This is very costly and a problem arises as to who will pay this cost. In most cases utilities are extended to the district boundary by the utility management and then installed in the district by its owners. Mr. Brooks Dodge of Cabot, Cabot and Forbes, Boston, Massachusetts, wrote the author: "It is usual to expect the utility services to be extended by the communities to the property line of the park. Within the park the costs are absorbed by the developer."[34]

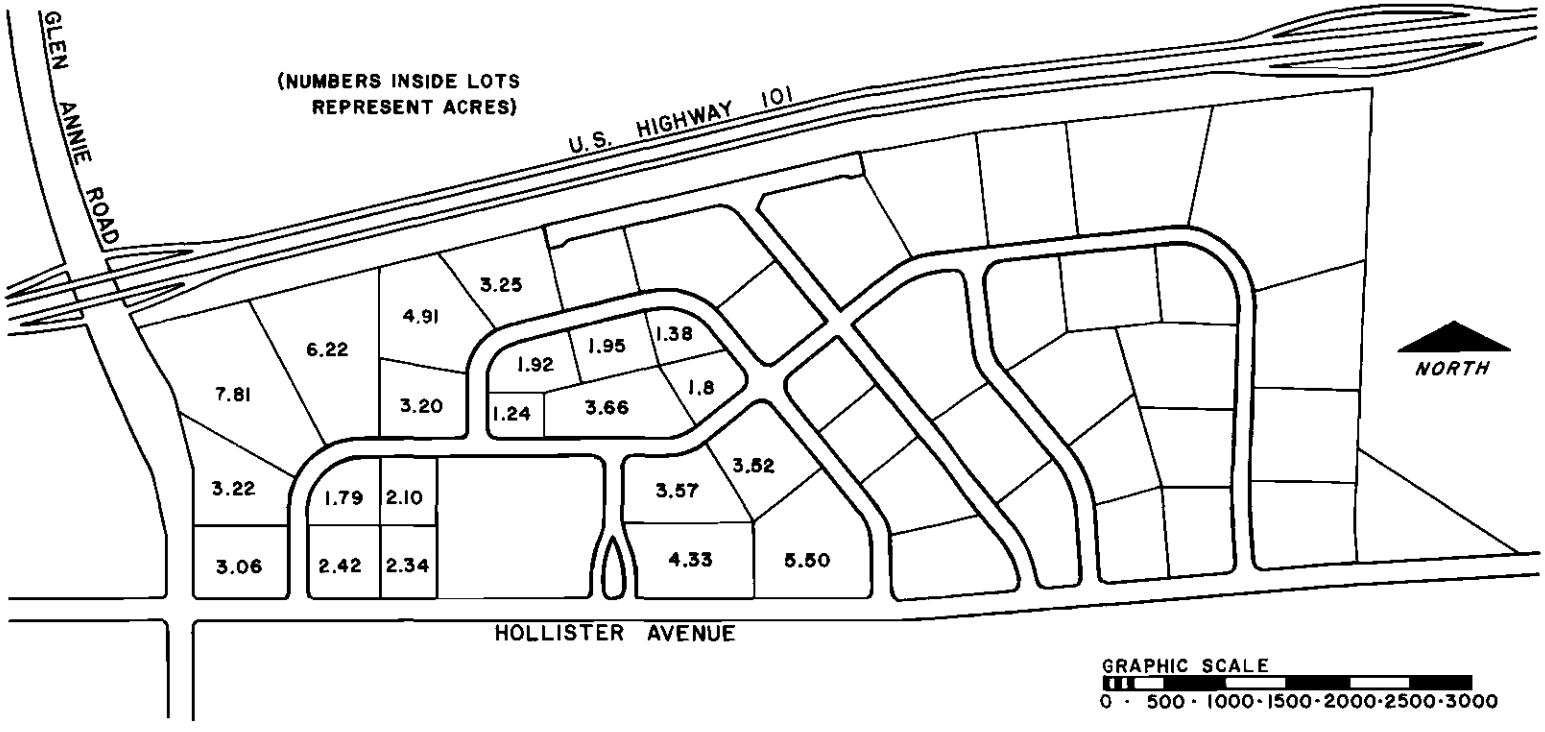

Figure 2. Site Plan of the Santa Barbara Research Park, Santa Barbara, California

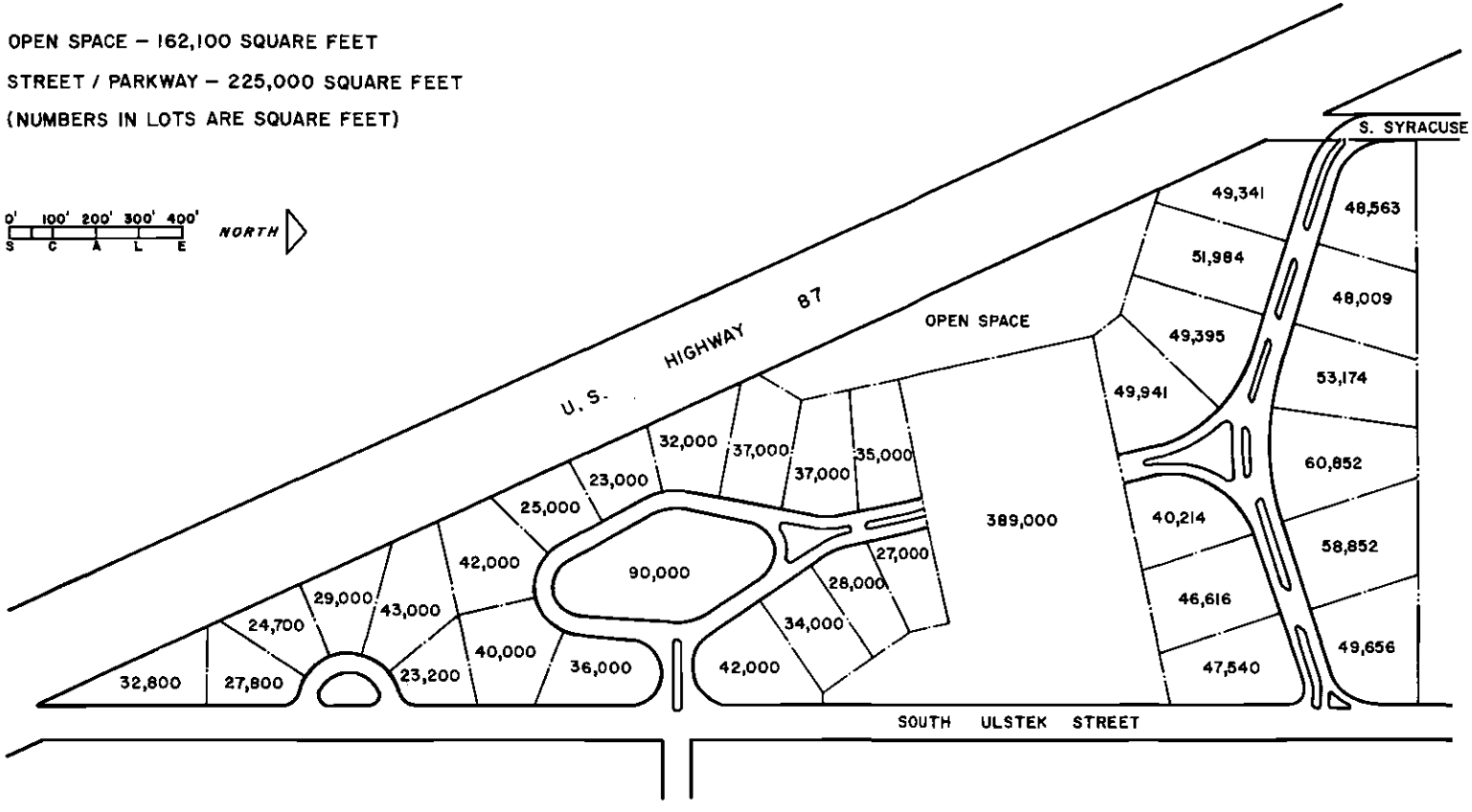

Figure 3. Site Plan of the Denver Technological Center, Denver, Colorado

Planning for each of the needed utilities will be discussed.

Water

The size of the water mains required will vary according to the types of facilities for which the district is being planned, *i.e.*, research and development operations only or these operations plus light manufacturing plants. Most districts have at least eight-inch water mains; smaller mains are not recommended.

Larger lines may be required if the district is to contain light manufacturing plants. For example, the Research Triangle Park, which is being planned to contain a sizeable number of light manufacturing plants, has an 18-inch water main.

Water mains larger than eight inches are needed for a district containing light manufacturing plants because:

1. Large water volumes are required by some manufacturing processes. For example, 470 gallons of water are required to produce a barrel of beer.

2. The air conditioning of manufacturing plants requires large amounts of water.

3. Insurance companies require that manufacturing plants, especially those which contain inflammable material (paperboard shipping boxes, for example), have adequate water available for fire protection.

The main should have two connections with the water system in order to form a loop. This will prevent dead-end lines and insure adequate pressure to all users in the district.

The cost of installing water mains varies with size, location, and sub-surface conditions. An average cost of installing an eight-inch

main, with fire hydrants every 450 feet, is $4.50 per foot.

Electricity

Specifying the electrical needs of a planned research and development district is beyond the scope of this study; such determination must be made by a qualified electrical engineer.

The types of research and development operations the district is likely to attract can have an influence on its electrical requirements. For example, chemical research and development laboratories do not require the electrical capacities and flexibility of other types. Pharmaceutical laboratories require greater electrical capacity and a variety of secondary voltages. Electronic and atomic power laboratories have high electrical requirements and need great flexibility in voltages and frequencies of the electricity supplied.[35]

Gas

Most research and development districts are served by gas mains of four or six inches; therefore, these size mains are recommended. Pressure should be at least 25 pounds per square inch in the main and as required (at least five PSI) in the lines serving the individual facilities.[36]

Sewers

Sanitary and storm sewers serving a district should be, whenever possible, tied in with a municipal system. Sanitary mains of at least eight inches are recommended and storm sewers should be of sufficient size to handle storm run-off.

It is recommended that a check be made of the types of wastes which the municipal sewage plant can treat before plans for the district

are completed. Some research and development laboratories have wastes which can not be taken by most municipal sewage treatment plants. For example, some laboratories emit acid wastes and solvents.[37] Atomic laboratories are likely to have radioactive wastes. In such cases it may be necessary to give these wastes special treatment before they can be discharged into the municipal system.

CHAPTER IV

SURVEY OF TWO PLANNED RESEARCH AND DEVELOPMENT DISTRICTS

A detailed description is presented of two planned research and development districts, the Huntsville (Alabama) Research Park and the Research Triangle Park, Raleigh, North Carolina.

These districts were chosen because of availability of information and a location reasonably near The Georgia Institute of Technology. Both districts are public developments being undertaken by subsidiaries of public corporations.

Huntsville Research Park

Initial planning for the Huntsville Research Park began in 1961 shortly after Dr. Werhner von Braun, Director, George C. Marshall Space Flight Center, requested the Alabama Legislature to authorize the establishment of a research institute in Huntsville. The Legislature authorized a $3,000,000 bond issue for this purpose and the State's electorate approved it in a referendum. The City of Huntsville and Madison County donated $400,000 to purchase 200 acres for the institute.

Realizing that the institute would add to the research and development "attractiveness" already provided by the space flight center, the City zoned 2,000 acres as a research park district. The Huntsville Industrial Expansion Committee through its land-holding subsidiary, Research Sites Foundation, Incorporated, purchased 600 acres of this

land and began to develop a research park.

Development Organization

The Huntsville Research Park is being developed by the Research Sites Foundation, Incorporated, a non-profit subsidiary of the Huntsville Industrial Expansion Committee. The Committee is composed of 350 members who contribute $100 per year to finance the Foundation.

Occupants

All the occupants of the park are conducting work directly related to the George C. Marshall Space Flight Center. All are doing research and development or closely related work; no light manufacturing is being done in the park.

The occupants can be classified into two types by function: (1) missile production and design, and (2) data processing. Examples of the first type are Lockheed and Boeing Aircraft companies and Thiokol Chemical Company. The two data processors are International Business Machines and Trans-Data Corporation.

Supporting Services

The most important supporting services for the park are provided through the University of Alabama Research Institute. Other services are available through private enterprises in the City.

University of Alabama Research Institute. The University of Alabama Research Institute is located on the University of Alabama (Huntsville) campus adjacent to the park, see Figure 4. Services available to the occupants of the park are the Institute's technical library and a UNIVAC 1107 computer. The computer is owned by the UNIVAC Company so arrangements for its use must be made through that company.[38]

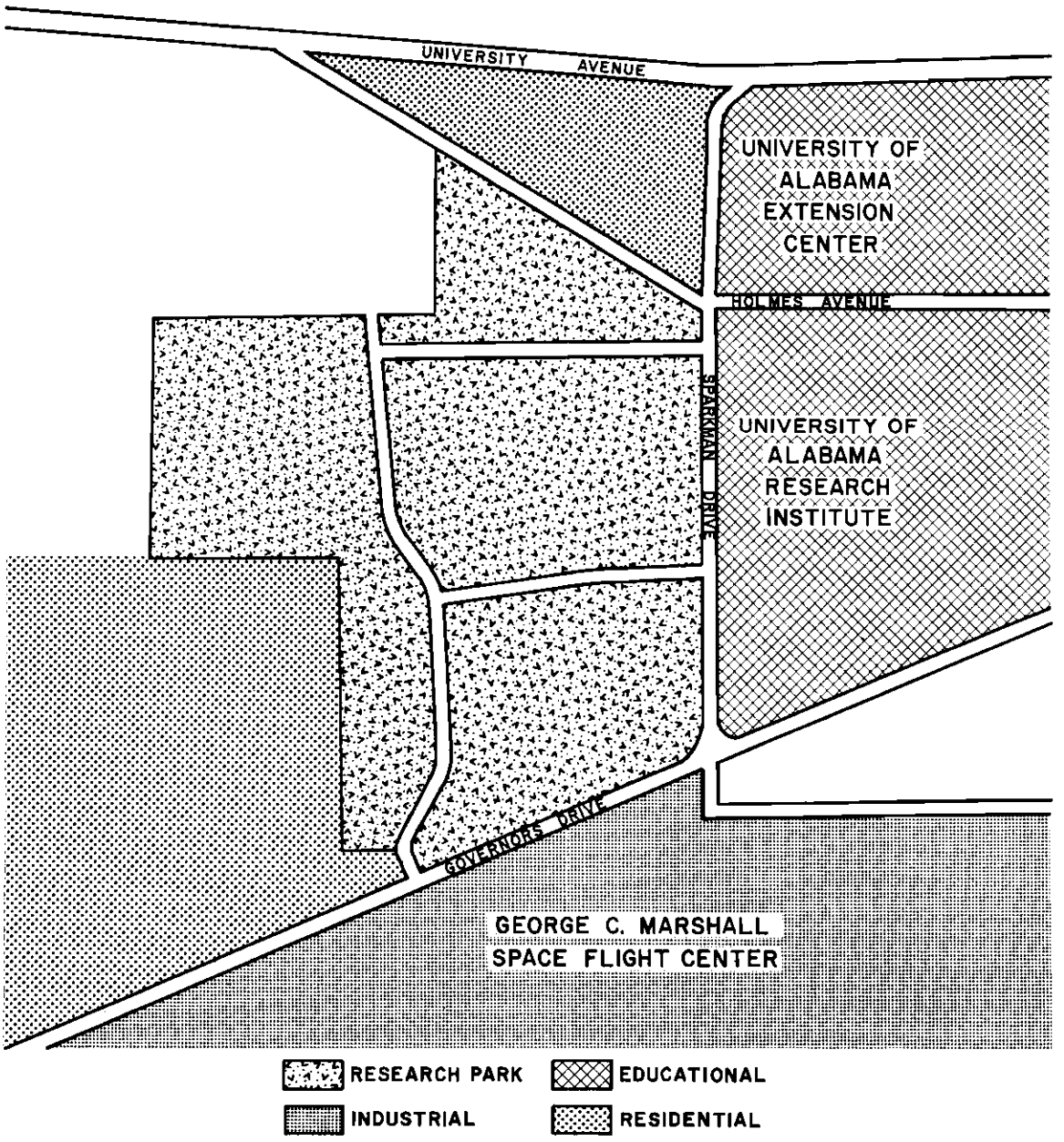

Figure 4. Huntsville Research Park Surrounding Land Uses

Other Supporting Services. Other supporting services are available in the City of Huntsville. The community is of sufficient size (estimated population, 120,000) to have many of the supporting services included in Table 5 (see page 29).

Surrounding Land Use

The land surrounding the park is used for: (1) educational, (2) residential, and (3) industrial purposes.

Educational. The land immediately east of the park is used by the University of Alabama for its Huntsville campus (see Figure 4). The campus contains the Research Institute and the Extension Center. The Research Institute conducts research in the aerospace physical sciences. It has laboratories and technical equipment for this purpose. The Extension Center is a purely educational facility offering undergraduate and graduate degrees in the physical sciences and engineering.

The use of this land for an educational campus is completely compatible with the park, it is even complementary.

Residential. The land west and north of the park is used for residential purposes. Most of the dwellings are single family and were built before the park was established.

The park has not had a detrimental effect on nearby residential uses. The zoning regulations which apply to the park insure that it will be developed in a manner which will not have an adverse effect on nearby land uses. Development controls will be discussed in more detail in a following section.

Industrial. The George C. Marshall Space Flight Center is located immediately south of Governor's Drive which forms the southern boundary of the park. The Center's 38,000 acres contain three installations: (1) Redstone Arsenal, (2) Headquarters for the U. S. Army Missile Command, and (3) the U. S. Army Ordinance Guided Missile School.

Redstone Arsenal is the major installation of the Center. The function of the Arsenal is to develop and produce rockets for space exploration. Employment is 9,000, including civil service and contractor personnel.[39]

The Headquarters of the U. S. Army Missile Command develops and produces missiles and rockets for the army. This function requires approximately 12,000 personnel.[40]

The U. S. Army Ordinance Guided Missile School is the smallest of the three facilities located on the Center. Its function is to train U. S. Army personnel in small missile maintenance.

Terms of Occupancy

Land is available in the Huntsville Research Park by purchase only. The management has no arrangements for leasing and offers no financial assistance for the construction of buildings.[41]

Development Controls

Development is controlled in the Huntsville Research Park by (1) zoning, and (2) restrictive covenants.

Zoning. The park is subject to the regulations of Article XIII, Research Park District, of the City of Huntsville Zoning Ordinance.[42] The Research Park District covers approximately 2,000 acres, including the 600 which are in the park.

The zoning regulations control uses permitted (see (4) of Appendix C), density, street access and frontage, and off-street parking. The regulations include performance standards and a development procedure for tracts and parcels and require that the Planning Commission adopt a Research Park Plan.

For assistance in administering the performance standards the Planning Commission has established the Research Park Technical Advisory Committee (see Figure 5). This committee is composed of National Aeronautics and Space Administration and Redstone Arsenal personnel who have the technical ability to assist the Planning Commission.

The development procedure for tracts and parcels was included in the regulations to insure that the park will be developed in accordance with the City's comprehensive plan. This part of the regulations is given below:

> Prior to the issuance of any building permit, notwithstanding other provisions of this ordinance, each parcel or tract of land must be approved for development by the Planning Commission. The Planning Commission shall hold a public hearing on such proposed land development after having notified adjoining property owners by registered mail. Within thirty (30) days after such proposed parcel development plan is duly submitted to the Planning Commission; the Commission shall either ascertain that said parcel development plan is in accordance with the elements of Huntsville's comprehensive plan and approve such parcel development plan; or, the Commission shall disapprove such parcel development plan and state in writing the reasons why such proposed parcel development plan does not conform with the City's plan or the requirements of this Ordinance. Failure of the Planning Commission to act within thirty (30) days after submittal of a parcel development plan shall constitute approval of such plan by the Commission.[43]

To offer assistance and guidance in carrying out the requirements of the development procedure the Planning Commission established the Research Park Advisory Board and the Research Park Committee (see

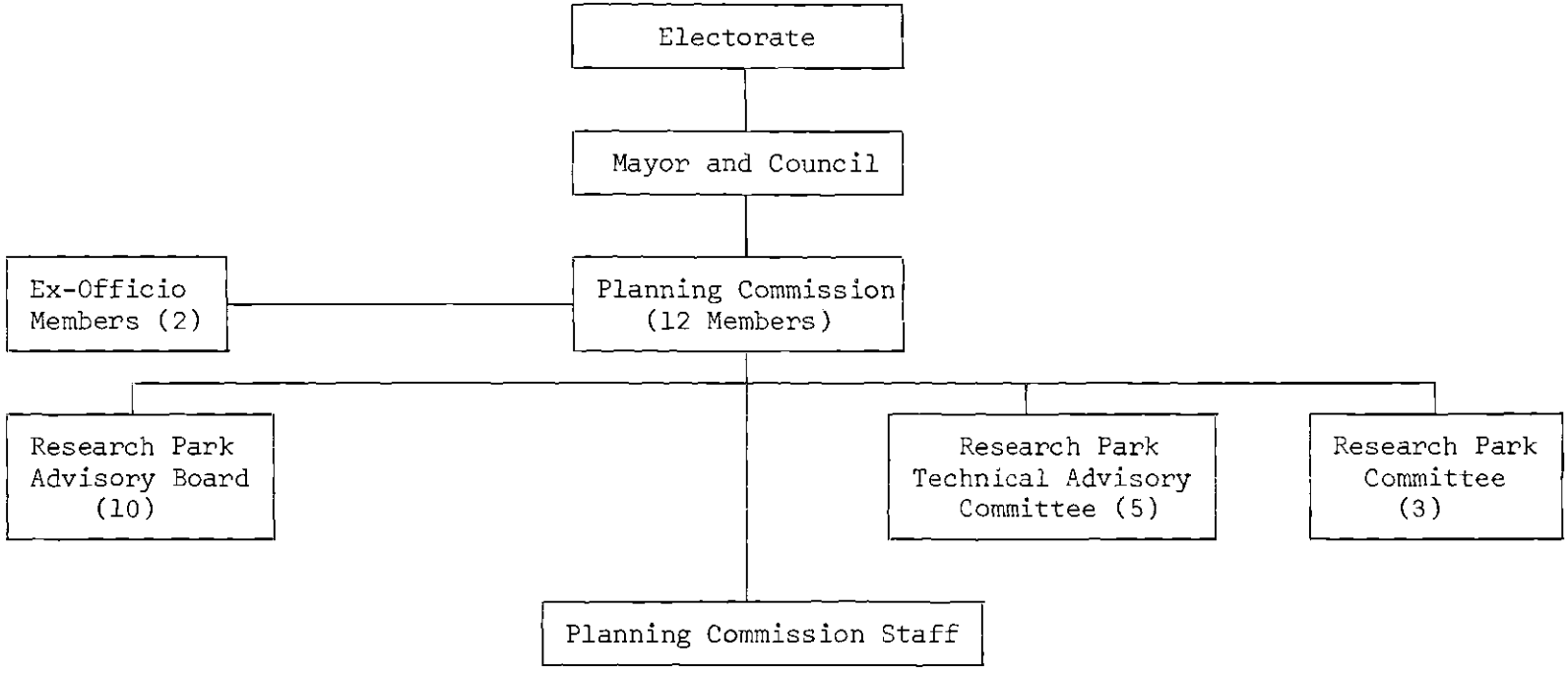

Figure 5. Research Parks Advisory Groups in the Huntsville, Alabama, Planning Commission

Figure 5). The advisory board, composed of park tenants, reviews engineering plans (such as plans for drainage facilities) and recommends development standards for the park as a whole.[44] The Research Park Committee determines if individual facilities to be built in the park conform to the zoning regulations.[45]

Restrictive Covenants. The author was unable to obtain a copy of the park's restrictive covenants.

Research Triangle Park

The 5,000-acre Research Triangle Park is located in the Piedmont section of North Carolina near the center of the triangle formed by Raleigh, Durham and Chapel Hill. Each of these cities has a major university: North Carolina State, Raleigh; Duke University, Durham; and The University of North Carolina, Chapel Hill.

Initial planning for the park was started in 1955 when Governor Luther C. Hodges appointed an informal committee called the Research Triangle Committee, Incorporated, to determine the feasibility of a research park in the research triangle area. The Committee decided that its first task should be to determine if the "research triangle concept" has validity. It set out to determine if the three universities, in reality, did form a triangle which would attract research and development operations. The Committee investigated the strengths of the three universities with emphasis on research underway at each.

The investigation indicated that the concept was sound, and the Committee adopted a three-phase program of work: (1) to make industry and government aware of the research resources of the research triangle,

(2) to establish a research park in the center of the research triangle, and (3) to establish a research institute in the research park.[46] In order to undertake these tasks, the Committee was chartered as a non-profit organization, the Research Triangle Foundation. A fund-raising drive was started to finance the Foundation and the citizens and businesses of North Carolina donated $2,000,000.

The remainder of this chapter will discuss the author's survey of the Research Triangle Park.

Development Organization

The organization responsible for the development of the Research Triangle Park is the Research Triangle Park, Incorporated, a wholly-owned subsidiary of the Research Triangle Foundation (see Figure 6). The Foundation is a non-profit organization similar to a holding company.[47] Its affairs are managed by a 25 member board of directors who are appointed by the Governor of North Carolina.

Occupants

The Research Triangle Park has nine occupants (see Table 6). For purposes of discussion they are grouped: (1) governmental, (2) industrial, and (3) institutional.

Governmental. The United States Government has two facilities in the park, the Forest Service's Forestry Science Laboratory and the Public Health Service's Environmental Health Service Center. The North Carolina Board of Science and Technology has its headquarters in the Park.

Industrial. The four industrial occupants are Beaunit Corporation, Chemstrand Research Center (Monsanto Chemical Company), Interna-

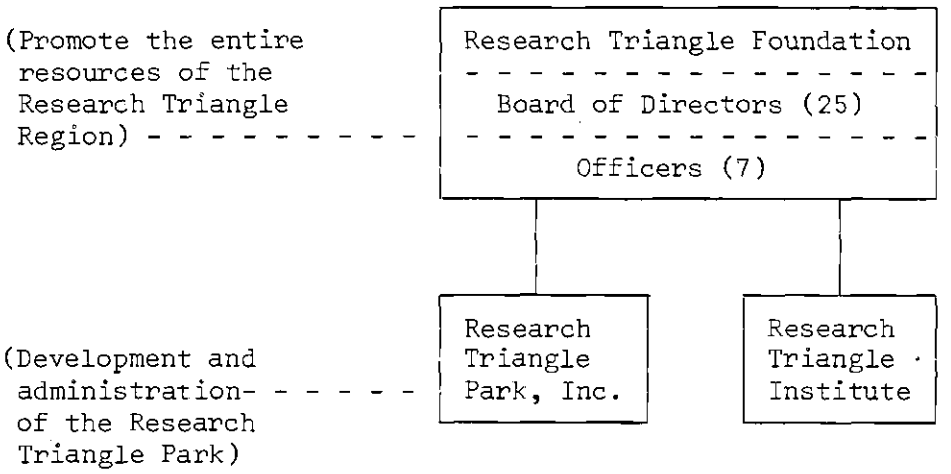

Figure 6. Development Organization of the Research Triangle Park

Table 6. Occupants of the Research Triangle Park

Occupant	Purpose	Site (Acres)	Number of Employees
GOVERNMENTAL			
(1) North Carolina Board of Science and Technology (RD)*	Technology transfer between industry	15	(NA)*
(2) U. S. Forest Service Forestry Science Laboratory (RD)	Forestry research	26	100
(3) U. S. Public Health Service Environmental Health Service Center (RAD)*	To study the effects of environmental factors on the health of man	500	1,000
INDUSTRIAL			
(1) Beaunit Corporation (RD)	Research on artificial fibers	100	500
(2) Chemstrand Research Center (RD)	Research on artificial fibers	100	500
(3) International Business Machines (RAD)	Manufacture computer components	400	2,500
(4) Technitrol, Inc. (RAD)	Research and manufacture of computer components	14	300
INSTITUTIONAL			
(1) American Association of Textile Chemists and Colorists (RD)	Research on the application of dyes and chemicals for the textile industry	16	(NA)
(2) Research Triangle Institute (RD)	Contract research	200	265

*Located in: (RD) Research District
(RAD) Research Applications District

(NA) Not available

tional Business Machines, and Technitrol, Incorporated. The first two mentioned are conducting research on artificial fibers and the other two manufacture computer components.

Institutional. Two institutional facilities are located in the park: the headquarters of the American Association of Textile Chemists and Colorists and the Research Triangle Institute. The Association does research for the textile industry and the Institute performs contract research.

Supporting Services

Supporting services for the occupants of the park are available at the Research Triangle Institute, three universities, and nearby cities.

Research Triangle Institute. The Research Triangle Institute is a contract research facility located at the approximate center of the park. This 90,000 square foot facility has 265 employees, 250 of whom are research specialists. The Institute's services are available to clients through six research laboratories and three divisions: research laboratories--(1) geophysics, (2) radiation systems, (3) natural products, (4) solid state, (5) measurement and controls, and (6) Camille Dreyfus (physics and chemistry of polymers); divisions--(1) statistics research, (2) operations research and economics, and (3) regional services.

Universities. Three large universities form the Research Triangle Region (see Figure 7): (1) Duke (Durham), (2) The University of North Carolina (Chapel Hill), and (3) North Carolina State University (Raleigh).

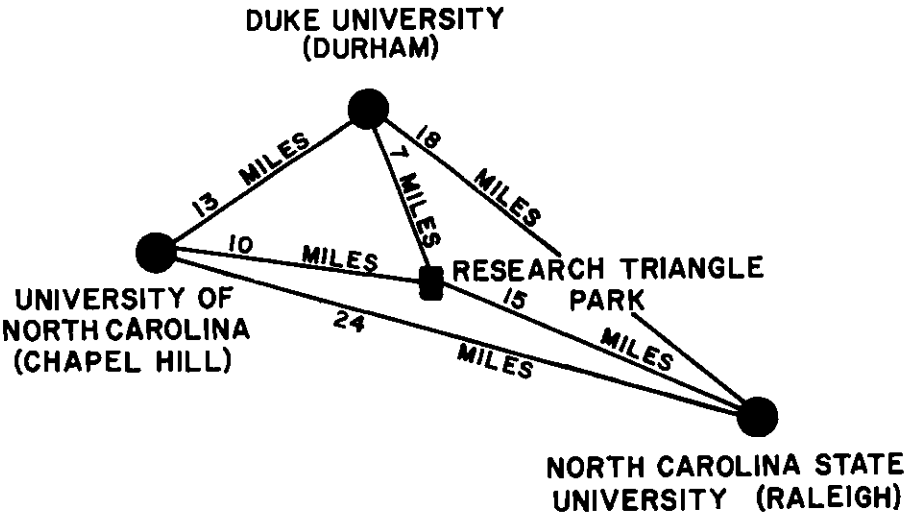

Figure 7. The Research Triangle Region

Duke University, seven miles from the Park, has 7,000 students and a faculty of approximately 800. In addition to a broad curriculum, the school has one of the outstanding libraries in the nation, 1,500,000 volumes.

The University of North Carolina, ten miles from the park, has an enrollment of 12,000 and a faculty of more than 1,000. This school offers the master's degree in 42 fields and the doctorage in 27. Its greatest strengths are in the field of chemistry, the natural sciences, mathematics, and mathematical statistics.[48]

North Carolina State University is 15 miles from the park. This school has an enrollment of 9,500 and 700 faculty members. Its main strengths are in the technological fields, and it offers the master's degree in a total of 38 fields and the doctorate in 28.

The availability of the more than 3,000,000 volumes in the three university libraries is the most important service that park occupants receive from the three schools. A wide range of equipment can also be used, such as a radioactive cobalt source at North Carolina State University and nuclear magnetic resonance equipment at Duke University and the University of North Carolina.

Other Supporting Services. The cities of Raleigh (95,000) and Durham (80,000) are large enough to provide many of the supporting services included in Table 5, page 29. Chapel Hill has a population of only 13,000 and is a university town so its supporting services are very limited.

Surrounding Land Use

Most of the land surrounding the Research Triangle Park is undeveloped and is being used for agricultural purposes. Scattered residential and commercial development (auto service stations, general merchandise stores, etc.) has occurred along North Carolina Route 55 west of the park and Old U. S. 70 to the east (see Figure 8).

Terms of Occupancy

Land is available in the park through purchase only. The current price is $3,000 per acre paid last by International Business Machines and Beaunit Corporation.[50]

The park management will construct buildings for lease (five-year minimum) with an option to buy.

Development Controls

Development in the Research Triangle Park is controlled by: (1) zoning and (2) restrictive covenants.

Zoning. The park is subject to the regulations of Sections XXXVII and XXXVIII of the Durham County, North Carolina, Zoning Ordinance. The park is divided (on the basis of land use) into two zoning districts: (1) a research district and (2) a research applications district (see Figure 8).

Section XXXVII regulates the research zoning district. This section controls uses permitted, building height, required lot area, lot coverage, yard size, location of accessory uses, parking and loading, and storage. It also contains performance standards. The uses permitted in the research zoning district include:

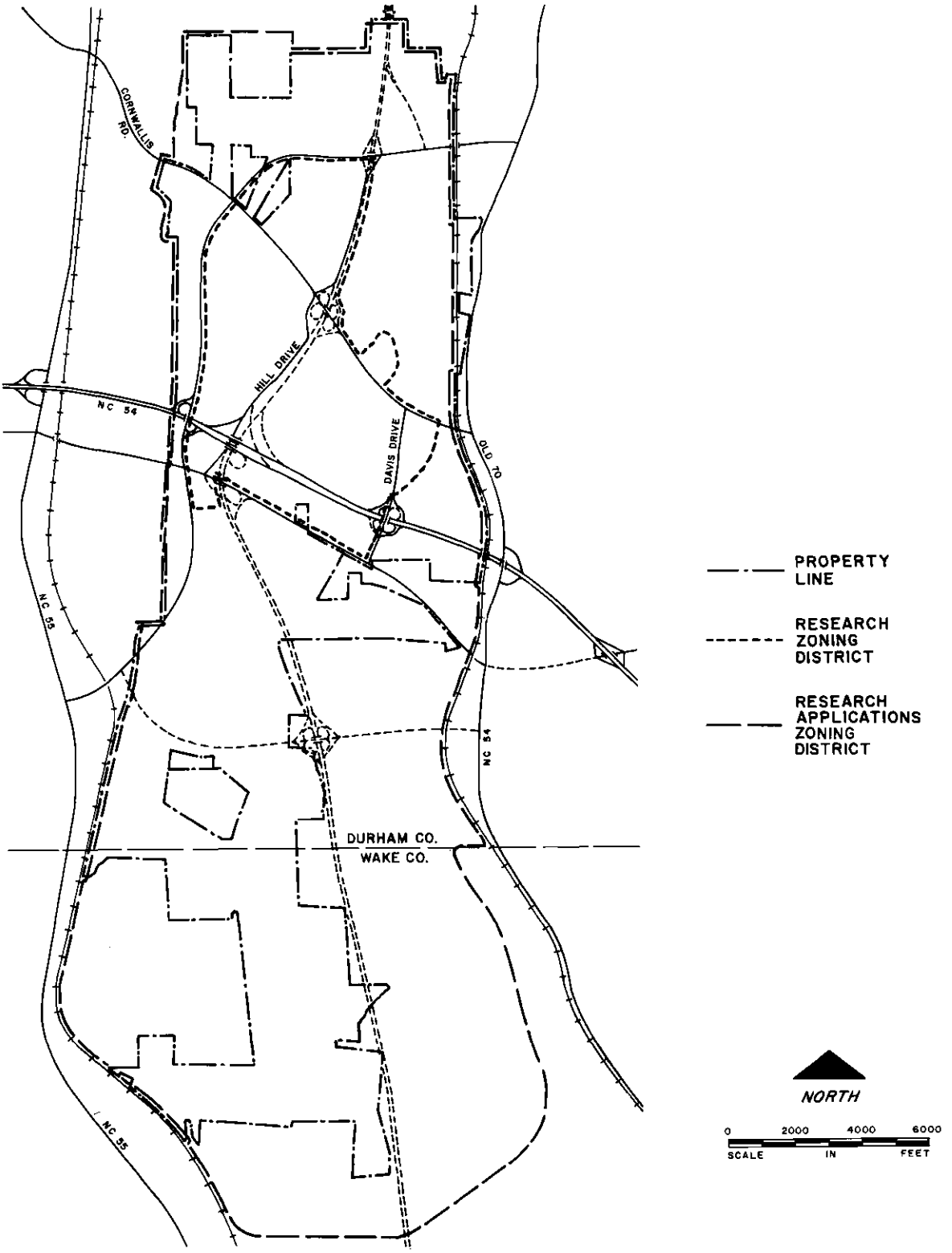

Figure 8. Surrounding Land Use and Zoning, Research Triangle Park

(1) research activities and related operations (production of products if they are to be used for testing and evaluation related to research and development);

(2) retail uses incidental to and in support of the uses in (1) (cafeterias, soda or dairy bars, and shops operated for the convenience of employees);

(3) operations required to maintain or support any use in (1) on the same tract as a permitted use (maintenance shops, power plants, keeping of animals, antenna farms and machine shops) and;

(4) agricultural or farming uses provided that the occupants are engaged in agricultural activities on the premises as their principal means of livelihood.

Section XXXVIII regulates the research applications zoning district. This zoning district was established to permit certain light manufacturing operations to locate in the park. Section XXXVIII contains the same types of regulations as Section XXXVII and the degree of control is the same, except for permitted uses. Permitted uses include:

(1) laboratories, offices, and other facilities for research; production of prototype products, and pilot plants; and

(2) production facilities with a high degree of scientific input.

The degree of scientific input a production facility has is measured by the proportion of professional, technical, and kindred workers to total employment in each facility. The proportion of such workers must be at least 7.5 (the manufacturing total) or the percentage listed in Table 7 for that industry category if it is higher than the

Table 7. Degree of Scientific Input Required of Production Facilities in the Research Applications Zoning District, Research Triangle Park

Industry Category	Percentage of Professional, Technical, and Kindred Employees Required
Manufacturing Total	7.5
Primary Non-Ferrous	7.5
Fabricated Metal	9.5
Machinery, Except electrical	9.5
Electrical Machinery, Equipment and Supplies	15.0
Aircraft and Parts	22.0
Professional and Photographic Equipment and Watches	16.0
Printing, Publishing	9.0
Synthetic Fibers	11.0
Drugs and Medicines	19.0
Paints and Varnishes	10.5
Miscellaneous Chemicals and Allied Products	16.0
Petroleum and Coal Products	15.0

Source: Section XXXVIII, Durham County, North Carolina, Zoning Ordinance, February, 1965.

NOTE: Employment Percentages by Industry Category are based on Table 2, PC(2)7C, U. S. Census of Population, 1960, Occupation by Industry.

manufacturing total.[51]

Restrictive Covenants. The restrictive covenants of the Research Triangle Park provide for the establishment of an Owners and Tenants Association and Board of Design. The restrictive covenants control uses, right-of-way easements, and resale rights.

Each owner and lessee of at least one acre in the park is a member of the Owners and Tenants Association. Voting rights in the association are based on the amount of land owned or leased as follows: (1) property owners--two votes for each acre of land owned but not leased; one vote for each acre owned but leased to a tenant; (2) lessees--one vote for each acre of land they lease. The United States Government cannot be a member of the association and is not bound by the restrictive covenants.[52] The Association appoints members to the Board of Design. The Board has five members who are appointed as discussed on page 17 in Chapter II.

The Board of Design controls development in the park under the following authority: "No construction or exterior alteration of buildings, utilities, signs, pavements, landscaping, or other facilities may be initiated without approval of plans by the Board of Design."[53]

The use regulations of the covenants are similar to those of the zoning ordinance.

The covenants provide that owners and tenants will permit reasonable easements for utilities and access roads on their property, with full compensation.

Conclusion

Planned research and development districts are relatively new enterprises. They have been established largely because of the current emphasis on research and development. Some have been improperly planned and located, and there is an over capacity of districts. A limited number of planned research and development facilities are being constructed, so the improperly planned districts will have to rely on light manufacturing plants in order to be financially successful.

The most important factor in determining the success of a district is its proximity to a research and development attractor: (1) a major university or (2) a scientific complex of the United States Government. Several districts have been established near universities which do not have the resources to qualify as attractors. Such districts do not reflect careful planning and have little chance of success as bona fide research and development districts.

APPENDIX

APPENDIX A

PLANNED RESEARCH AND DEVELOPMENT DISTRICTS SURVEYED

Alabama

1. Huntsville Research Park--Huntsville

Arizona

2. Research Park West--Tucson

California

3. Pomona Colleges R&D Center--Pomona
4. Santa Barbara Research Park--Santa Barbara
5. Peralta Oaks Research Center--Oakland
6. Stanford Industrial Park--Palo Alto
7. Palos Verdes Research Park--Palos Verdes
8. International Science Center--Sunnyvale
9. Del Monte Research Park--Monterey

Colorado

10. Boulder Technological Center--Boulder
11. Colorado Industrial and Research Campus--Boulder
12. Colorado State University Industrial Research Park--Ft. Collins
13. Denver Technological Center--Denver

Connecticut

14. Connecticut Research Center--Meriden & Wallingford

Georgia

15. University of Georgia Research Park--Athens

Illinois

16. Interstate Research Park--Champaign

17. Tawney Research Park--Urbana

Indiana

18. McClure Research and Development Park--West LaFayette

Kansas

19. Research Park, Inc.--Manhattan

Maryland

20. Danac Technological Park--Rockville

21. National Capital Research Park--Rockville

22. Washington Science Center--Rockville

Massachusetts

23. Technology Square--Cambridge

Michigan

24. Greater Ann Arbor Research Park--Ann Arbor

Missouri

25. University of Missouri Research Park--Columbia

New Jersey

26. Princessville Research Park--Princeton

27. Princeton Research Park--Princeton

New Mexico

28. University Research Park--Albuquerque

New York

29. Cornell University Industry Research Park--Ithaca

North Carolina

30. Research Triangle Park--Raleigh-Durham

Ohio

31. University Circle Research Center--Cleveland

Oklahoma

32. University of Oklahoma Research Park--Norman

Oregon

33. Sunset Science Park--Portland

South Carolina

34. Ravenel Research Center--Clemson

Texas

35. Dallas North Research Park--Dallas

36. Clear Lake City Research Park--Houston

Virginia

37. University Research Park (Virginia Polytechnic Institute)--Blacksburg

Wisconsin

38. Fitchburg Research Park--Madison

APPENDIX B

SANTA BARBARA RESEARCH PARK

OWNERS AND TENANTS ASSOCIATION

6. To select owner and tenant members of the Board of Design set forth in the following paragraph, and to establish an association of tenants and owners of property within the Santa Barbara Research Park, there is hereby established the SANTA BARBARA RESEARCH PARK OWNERS AND TENANTS ASSOCIATION, hereinafter referred to as the "association." Each owner or tenant of one (1) acre or more of land within the SANTA BARBARA RESEARCH PARK which is subject to these covenants, restrictions and reservations, and whose principal facility on said land is used for research purposes, is a member of the Association, and shall have the same number of votes in proportion to the number of acres owned or leased. Land shall be deemed to be used for research purposes when the principal facility located thereon is for such purpose, or if such facility has not been completed, when the foundations therefore have been laid in accordance with plans approved by the Board of Design. Where the land is leased by an owner to a tenant and the tenant is the entity which is using the principal research facility on the land, the votes specified shall be deemed to be the tenant's and not the owner's. Grantor shall have the number of votes proportionate to the number of acres owned, less the number of votes attributed to tenants of Grantor who meet the above qualifications.[54]

APPENDIX C

USES PERMITTED BY THE ZONING ORDINANCES OF SELECTED PLANNED RESEARCH AND DEVELOPMENT DISTRICTS

(1) Stanford Industrial Research Park, Palo Alto, California, City of Palo Alto, Article 15B

Uses Permitted. (a) Professional and administrative offices

(b) Manufacturing, processing, assembling, or storage of products and materials, including institutes and laboratories, provided that such uses are not or will not be offensive by reason of the emission of dust, gas, smoke, noise, fumes, odors, or vibrations, or otherwise.

Other Uses Permitted in Same Zoning District. Service stations as a conditional use.

(2) Greater Ann Arbor Research Park, Ann Arbor, Michigan, City of Ann Arbor, Article 5:21

Uses Permitted. (a) Industrial research, development and testing laboratories, and offices.

(b) Scientific research, development and testing laboratories, and offices.

(c) Business research, development and testing laboratories, and offices.

Other Uses Permitted in Same Zoning District. None

(3) Sunset Science Park, Portland, Oregon, Washington County, Oregon, Article 1150-1156

Uses Permitted. 1. Laboratories

a. Research and development

b. Testing

2. Assembly and manufacturing of the following in connection with research and development.

   a. Electronic instruments

   b. Optical, medical, dental and scientific precision instruments and equipment

   c. Medicines and pharmaceuticals

   d. Any other use held suitable, as determined by the Planning Commission

3. Offices for research purposes or when related to the above uses.

4. Warehousing, storage and distribution only when related to the above uses.

5. Public service and utility uses.

6. Temporary structures for uses incidental to construction work which shall be removed upon completion or abandonment of the construction work.

7. Signs.

Other Uses Permitted in Same Zoning District. None.

(4) Huntsville Research Park, Huntsville, Alabama, City of Huntsville, Article 13

Uses Permitted.

1. Dwellings only in connection with agricultural operations, or in subdivisions recorded prior to April 12, 1962.

2. Farming and other agricultural uses.

3. Federal, state, county, or city owned or operated buildings and uses.

4. Office buildings.

5. Research, experimental and testing laboratories.

6. Educational institutions and related uses.

7. Industrial uses primarily research and development and limited manufacturing as regulated by performance standards.

8. Structures accessory to uses.

9. Signs, except outdoor advertising posters.

10. Accessory uses to uses permitted such as recreation and dining facilities in connection with the operation of an establishment and primarily for employees, students or faculty.

11. Heliport, nuclear reactor, radio or television studio and transmitters and towers, as regulated by performance standards.

12. Retail sales and consumer service establishments (not including warehouse sales), accessory to any permitted use, other than agricultural or residential uses, and dealing primarily with employees, students or faculty of establishments permitted as principal uses, provided that such uses shall not occupy more than five per cent of the total floor area of all buildings on any lot or group of contiguous lots in common ownership or control.

Other Uses Permitted in Same Zoning District. None

(5) Colorado Industrial and Research Campus, Boulder, Colorado, Boulder County, Colorado, Section X

Uses Permitted. Special developments such as scientific research laboratories, planned industrial parks, regional office buildings and recreational projects, provided no building structure, or premises shall be used and no building or structure shall be erected for any use until and unless a site plan showing the location of proposed buildings and/or other improvements shall have been approved by the County Planning Commission following a public notice and hearing as provided in Section XXIV.

Other Uses Permitted in Same Zoning District. By special review (section XV) and subject to such conditions and safeguards as may be imposed by the Board of County Commissioners:

(1) Water tanks, water treatment facilities, utility substations and regulator stations
(2) Planned unit developments.

(6) Manhattan Research Park, Manhattan, Kansas, City of Manhattan, Section 12

Uses Permitted.

1. Research facilities
2. Office and laboratories (all proposals for construction, expansion and remodeling of buildings, and physical facilities, and appurtenances thereto, must be first submitted for recommendation to the Planning Board and approved by the City Commission).

Other Uses Permitted in Same Zoning District. None

LITERATURE CITED

1. Snider, Robert G., *Research Parks as Real Estate Developments.* Speech before the Eighteenth National Conference on the Administration of Research, Princeton, New Jersey, September 10, 1964, p. 4.

2. Terleckyj, Nestor E., "Research and Development, Its Growth and Composition," *Studies in Business Economics,* No. 82, March, 1965, p. 10.

3. *Ibid.,* p. 11.

4. Brown, Theodore B., "The Changing Research Parks," *Industrial Research,* Vol. 8, No. 5, May, 1966, p. 42.

5. *Ibid.*

6. University Circle Research Center. Personal interview with Stanley v. Michota, Jr., Vice President, University Circle Research Center, Cleveland, Ohio. November 9, 1966.

7. Griefen, John. "A Research Park Does Not Live by Research Alone," *Urban Land,* Vol. 24, No. 3, March, 1965, p. 103.

8. Snider, *op. cit.,* p. 5.

9. Griefen, *op. cit.,* p. 5.

10. Federal Aviation Agency, *Planning the Airport Industrial Park,* Washington, D. C., September 30, 1965, p. 7.

11. Danac Real Estate Investment Corporation. Personal letter from Mr. Michael F. Johnson, Vice President, Danac Real Estate Investment Corporation, Rockville, Maryland. July 5, 1966.

12. Arthur D. Little, Incorporated. *Georgia Tech Impetus to Economic Growth.* Boston: November, 1963, p. 55.

13. Federal Reserve Bank of Richmond, Virginia. *Monthly Review,* "North Carolina's Research Triangle," November, 1962, p. 8.

14. University Circle Research Center. Personal interview with Stanley V. Michota, Jr., *op. cit.*

15. Schwitter, J. P., "Why Sponsor an Industrial Research Park," *College and University Business,* Vol. 36, No. 5, p. 80.

16. University of Missouri. Personal letter from Mr. A. H. Emmons, Director Research Reactor Facility, University of Missouri, Columbia, Missouri, July 10, 1964.

17. Little, "Georgia Tech, Impetus to Economic Growth," *op. cit.*, p. 9.

18. University Circle Research Center. Personal interview with Stanley V. Michota, Jr., *op. cit.*

19. Little, "Georgia Tech, Impetus to Economic Growth," *op. cit.*, p. 9.

20. Denver Technological Center. "Declaration of Protective Covenants," Denver, Colorado, p. 11.

21. Santa Barbara Research Park. "Restrictive Covenants and Performance Standards," Santa Barbara, California, p. 4.

22. International City Managers Association. *Local Planning Administration*, Chicago, Illinois: the Association, 1959, p. 306.

23. Danilov, Victor J., "What Makes a Desirable Science Site?" *Industrial Research*, Vol. 8, No. 5, May, 1966, p. 37.

24. American Council on Education. *An Assessment of Quality in Graduate Education.* Washington, D. C.: the Council, 1966, p. 10.

25. Brown, *op. cit.*, p. 42.

26. "Salary Survey Shows Concern Over Fringe Benefits," *Industrial Research*, Vol. 8, No. 2, February, 1966, p. 75.

27. Brown, Willard S., "The Development of an Urban Industrial Research Center." An address at the Eighteenth National Conference on the Administration of Research, Princeton, New Jersey, September 10, 1964.

28. University Circle Research Center. Personal interview with Stanley V. Michota, Jr., *op. cit.*

29. McKee, Logan A., Jr., *Planned Industrial Districts.* Unpublished Master's thesis, Department of City Planning, Georgia Institute of Technology, 1955, p. 142.

30. Hill and Adley Associates. *Selection Factors for an Industrial Park.* Atlanta, Georgia: April, 1962, p. 3.

31. *Ibid.*

32. Walton, Sidney, *How to Make a Killing in Real Estate*, Profit Research, Incorporated, Mineola, New York, 1963, p. 96.

33. Atlanta Region Metropolitan Planning Commission. *Economic Potentials, the Outlook for Research and Development in Metropolitan Atlanta.* Atlanta, Georgia: the Commission, December, 1962, p. 23.

34. Cabot, Cabot and Forbes. Personal letter from Mr. Brooks Dodge, Projects Manager, Cabot, Cabot and Forbes, Boston, Massachusetts, July 10, 1964.

35. Whitney, Frank L., "Design for Research Facilities," *Industrial Research,* Vol. 4, No. 8, September, 1962, p. 44.

36. McKee, *op. cit.,* p. 92.

37. Whitney, *op. cit.,* p. 44.

38. University of Alabama Extension Center. Personal letter from Mr. Philip M. Mason, Director, University of Alabama Extension Center, Huntsville, Alabama, November 17, 1966.

39. *NASA, Marshall Space Flight Center.* A brochure of the Huntsville Industrial Expansion Committee, Huntsville, Alabama, n.d.

40. *U. S. Army, AMC-OGMS.* A brochure by the Huntsville Industrial Expansion Committee, Huntsville, Alabama, n.d.

41. Huntsville Industrial Expansion Committee. Personal letter from Mr. Guy B. Nurren, Executive Director, Huntsville Industrial Expansion Committee, Huntsville, Alabama, December 18, 1964.

42. City of Huntsville, Alabama. *Zoning Ordinance.* Huntsville, Alabama, City Planning Commission, March, 1963, p. 13.

43. *Ibid.,* p. 19.

44. Huntsville, Alabama, Planning Commission. Personal interview with Dean Y. Matthews, Director, Huntsville, Alabama, Planning Commission, Huntsville, Alabama, November 25, 1964.

45. *Ibid.*

46. Hodges, Luther C., "The Research Triangle of North Carolina," *State Government,* Vol. XXXIII, No. 1, Winter, 1960, p. 17.

47. Federal Reserve Bank of Richmond, Virginia, *op. cit.,* p. 9.

48. The Research Triangle Foundation. *A Dynamic Concept for Research,* a Publication of the Research Triangle Foundation, Raleigh, North Carolina, p. 10, n.d.

49. *Ibid.,* p. 8.

50. The Research Triangle Regional Planning Commission. Personal interview with Pearson H. Stewart, Executive Director, the Research Triangle Regional Planning Commission, Raleigh, North Carolina, June 10, 1966.

51. Durham County, North Carolina. *Zoning Ordinance,* Section XXXVIII, Research Applications District, Durham County, North Carolina, p. 1.

52. Research Triangle Park, Incorporated, *Restrictive Covenants.* Raleigh, North Carolina: the Park, August, 1965, pp. 5 and 10.

53. *Ibid.,* p. 6.

54. Santa Barbara Research Park, *op. cit.,* p. 3.